Hydrophobic surfaces are useful for many applications, such as anti-fouling coatings or self-cleaning surfaces amongst others. The hydrophobic properties of a surface can be characterized by analyzing the wetting characteristics. The evaluation of both static and dynamic wetting properties are of great significance to understanding hydrophobic surfaces in detail. The static wetting properties determine the equilibrium shape of a drop on a solid surface, while the dynamic wetting properties can shed light on the adhesive properties of a liquid on a surface. The ***tilting based method*** *is* ***one of the most common techniques*** *to observe the dynamic wetting behaviour, which can provide* ***advancing contact angle***, ***receding contact angle*** *and the* ***contact angle hysteresis (CAH)*** *in an* ***easy*** *and* ***reliable*** *procedure. In the following an application of the method will be presented using PTFE foils and metallic plates as samples.*

Fig. 1. Water droplet rolling off a hydrophobic surface.

Keywords: OCA ▪ TBU ▪ Dynamic Contact Angle ▪ Tilting Based Method ▪ PTFE Foils ▪ Metallic Plates ▪ Hydrophobic Surfaces

Technique and Method

For measuring dynamic contact angles (Dyn. CA) according to the tilting based method, the solid sample has to be tilted from its horizontal position. The dropshape will be influenced by gravity on the inclined platform. While tilting the shape of the droplet becomes asymmetrical and it starts to move when it reaches a certain tilting angle (Fig. 2). The advancing contact angle (Adv. CA) is the angle at the lower end of the drop while, the angle at the higher end is the receding contact angle (Rec. CA). Hence, measuring dyn. CA on a tilted sample directly yields the Adv. CA, Rec. CA and tilting angle as well as the CAH.

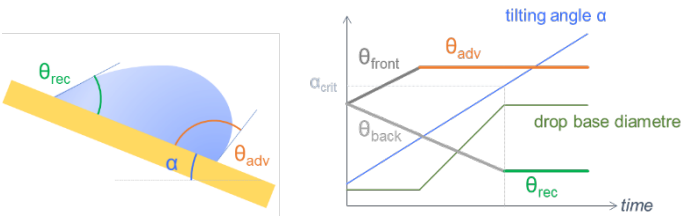

Fig. 2. Dynamic contact angle measurements according to the tilting base method.

The electronic tilting base units TBU 100 or TBU 100EC fully automatically tilt the entire OCA device (Fig. 3) in a **range from -5° to +95°** including attachments like dosing systems and environmental chambers. By tilting the entire system the position of the sessile drop/baseline within the optical axis does not change facilitating the analysis of dynamic contact angles. Hence, a combination of TBU and OCA opens an **easy and reliable way to measure dynamic contact angles** on different kinds of materials like the PTFE foils and coated metallic plates that will be presented in this application note.

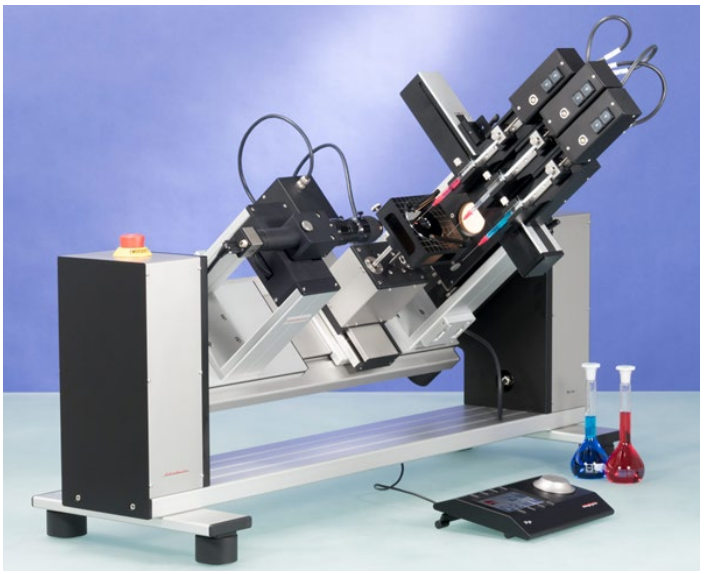

Fig. 3. Tilting base unit TBU with OCA 50 form DataPhysics Instruments.

Experiment

The dynamic contact angles on three different kinds of PTFE foils and on three different kinds of coated metallic plates were determined with a combination of OCA and TBU 100.

To ensure accuracy and reproducibility of the results, measurements were carried out three times per sample. The PTFE foils were fixed with double-sided adhesive tape on the sample stage. The coated metallic samples were directly fixed on a special magnetic sample stage.

Water drops with a volume of 20 µl were placed on a PTFE foil sample and the static CA was recorded. Then, the sample was tilted using a tilting device (TBU) until the water drop rolled off the surface. At the same time, a video was recorded

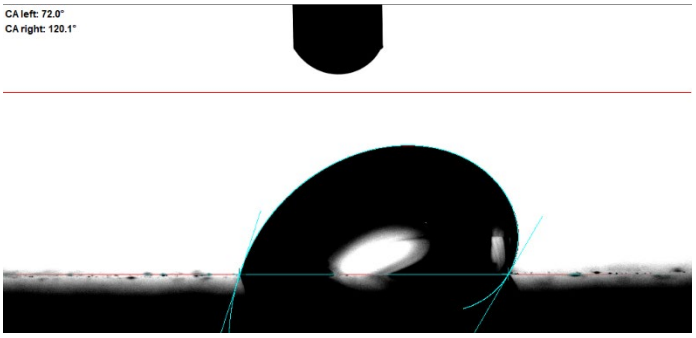

Fig. 4. Determination of the advancing angle (right) and the receding angle (left) with the SCA software.

with the SCA software for determining the Adv. CA (right) and the Rec. CA (left) (Fig. 4).

The same method as described above was used to determine the dyn. CAs on the coated metallic samples, but the droplet volume was increased to 40-60 µl to facilitate the roll-off.

After automatic evaluation with the SCA software, the mean static CAs and dynamic CAs of all samples were obtained utilizing Laplace-Yang Fitting and Polynomial Fitting, respectively.

Results

Fig. 5 and Fig. 6 show the static, advancing and receding contact angles as well as CAHs that were determined for the studied samples. The static contact angle values of the all samples are between 110 ° and 150 °, indicating hydrophobic surfaces.

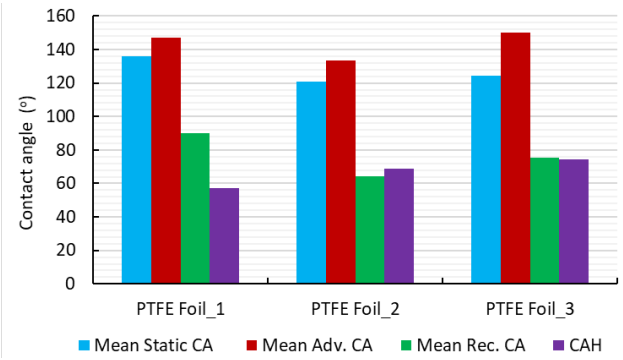

Fig. 5 Static and dynamic CAs on the PTFE foil samples.

Besides, the difference between advancing and receding contact angle, i.e. CAH, which is caused by the surface roughness and its mechanical or chemical heterogeneity, has been calculated. The CAH is critical for the mobility evaluation of a drop on a surface. The larger the CAH, the less mobile is a drop on this surface making the CAH an indicator for adhesion strength.

As shown in Fig.5, the CAH on PTFE Foil_1 is lowest, which implies that the mobility of water droplets on the surface of PTFE Foil_1 is highest and the adhesion between them is lowest. The CAH on PTFE Foil_3 is highest, indicating the highest adhesion between water and this surface.

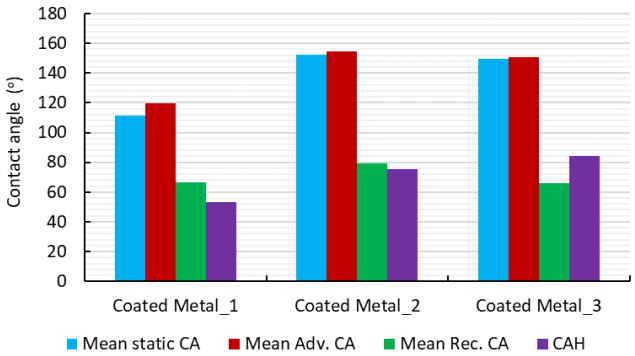

Fig. 6. Static and dynamic CA on the coated metallic samples

Likewise, for the coated metallic samples, as seen in Fig. 6, coated metal_3 showed the highest CAH and thus the mobility of a water drop on this surface is lower compared to the other two samples. In addition, the drop could not roll off from the surface of coated metal_3 if the drop volume was lower than 60 µl.

It is of great significance to study the static and dynamic CA for getting a deeper understanding for the wetting properties of hydrophobic surfaces. With **a combination of OCA and TBU, the static and dynamic CAs** can be obtained **easily and reliably with high reproducibility**.

Summary

The optical contact angle measuring and contour analysis system **OCA** in combination with the tilting base unit **TBU** from DataPhysics Instruments provided **a simple and reliable method** to determine **static and dynamic contact angles** on hydrophobic PTFE foils and coated metallic samples for evaluating their wetting properties.

This techinique is a classical but **one of the most powerful** methods to study the wetting characteritics and understand adhesion behaviours, which is curical in many industrial processes, like **painting**, **self-cleaning**, **coating** etc.

Reference

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